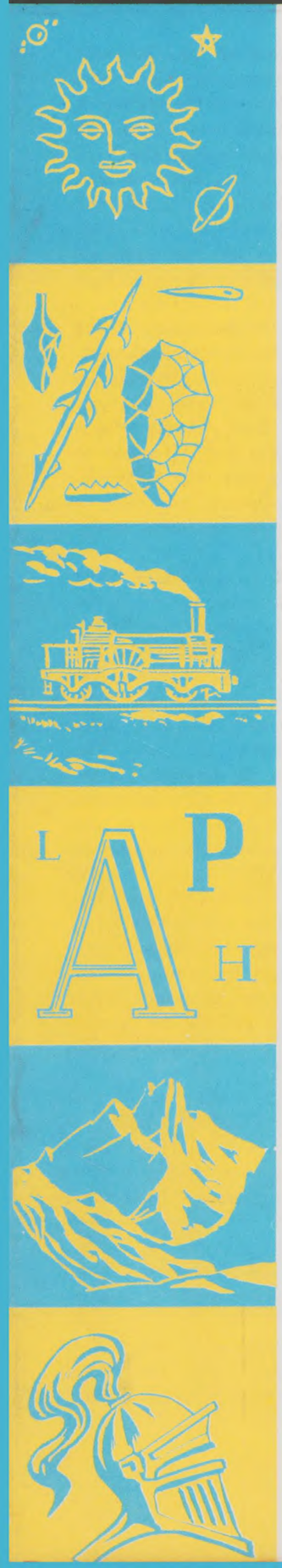
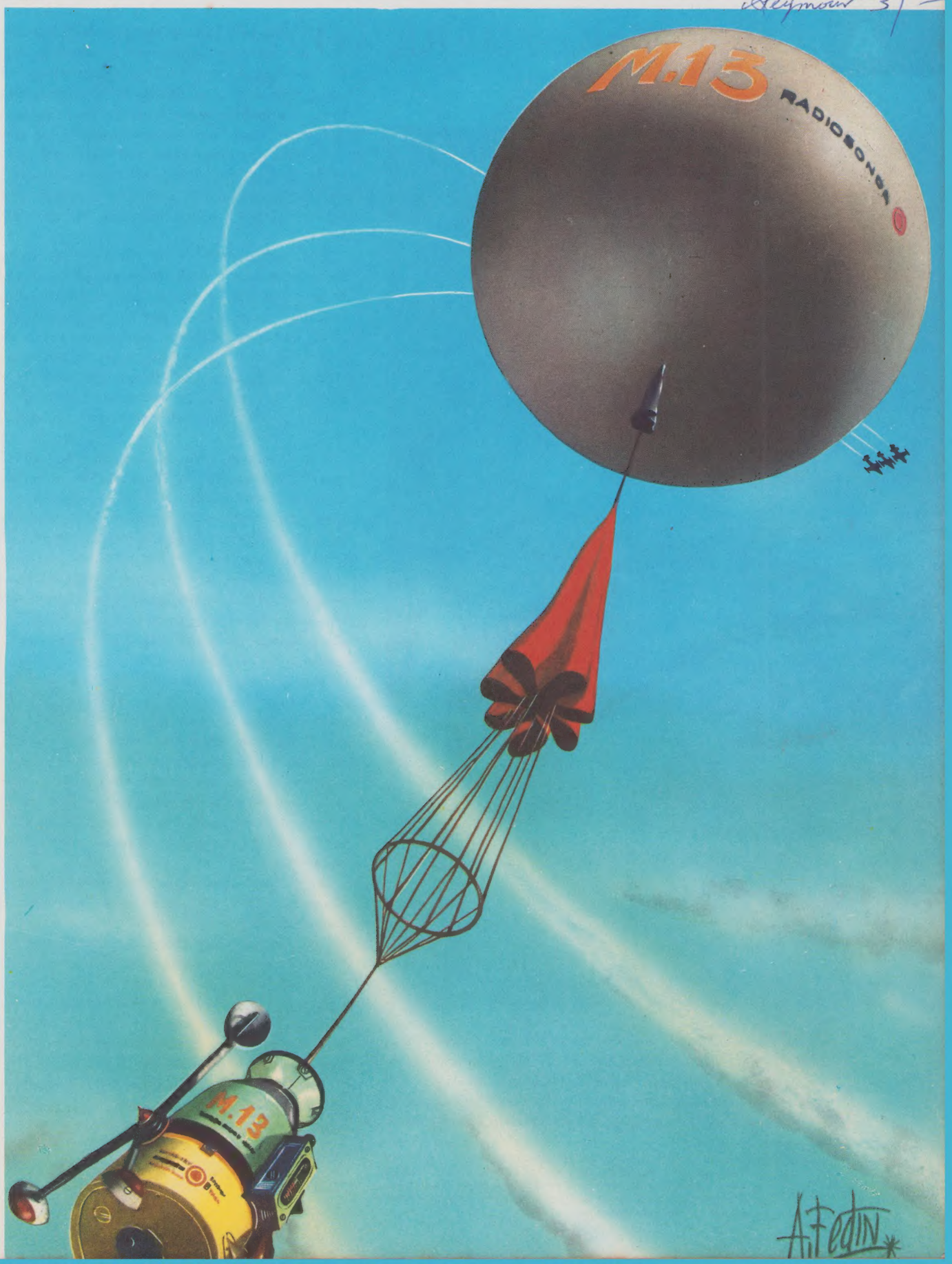
KNOWLEDGE

NO. 149 VOLUME 13 The colour magazine which grows into an encyclopaedia EVERY MONDAY 2/-





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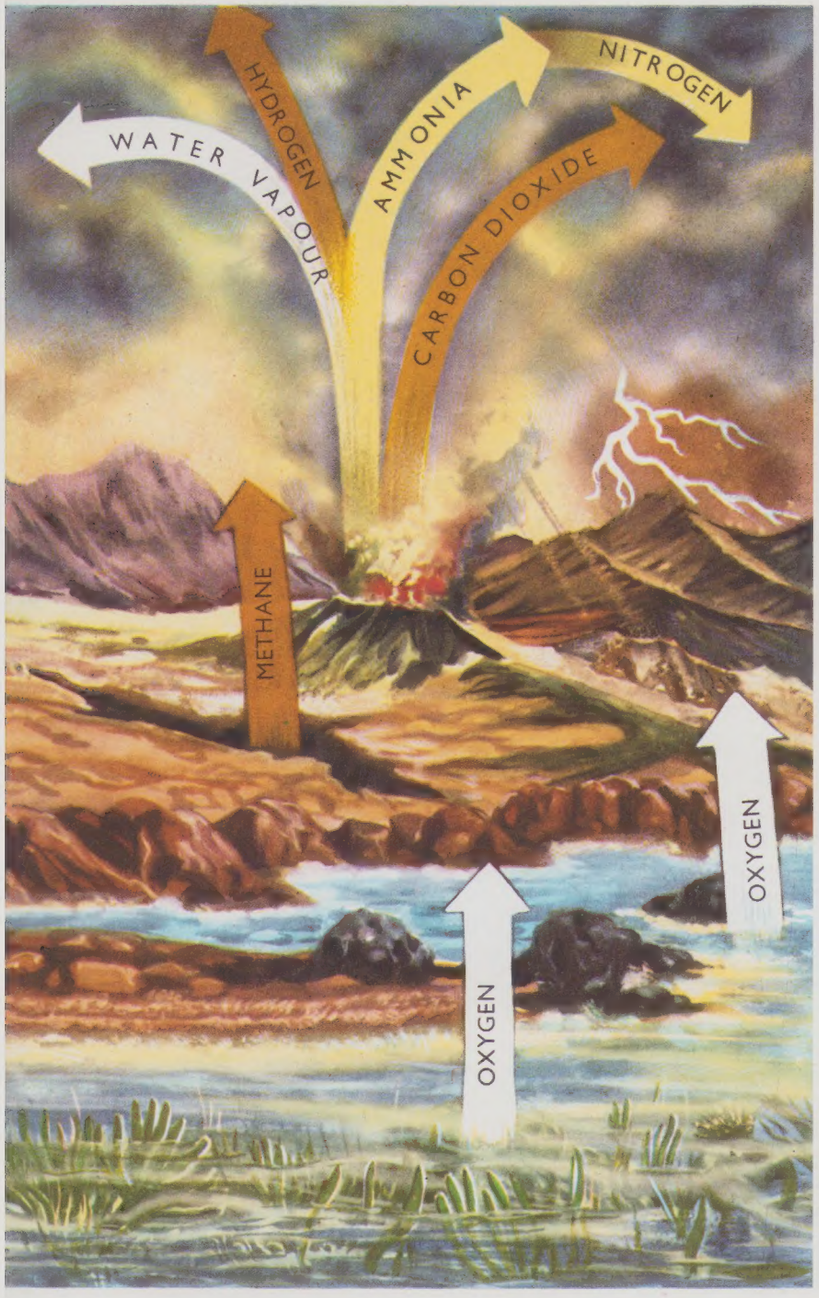
A THE ATMOSPHERE



As the Earth cooled the atmosphere of hot gas around it was slowly replaced from within by one of nitrogen, ammonia, hydrogen, carbon dioxide, water vapour, and methane. The oxygen appeared much later, possibly from the decomposition of water vapour by ultra-violet light, possibly from plants

Previous page: A radio-sonde which has an automatic radio reporting temperature, humidity, and air pressure. When sondes are tracked by radar the wind velocity can be estimated also. The balloons burst about 25 miles up and the instrument falls gently to Earth by parachute.

ON 19th July 1963 an eight-jet B-52 bomber took off from Edwards Air Base in California. It was not, however, carrying bombs; its load was a tiny X-15 aeroplane slung underneath the starboard wing. Upwards climbed the B-52 until it reached a height of 45,000 feet, or approximately 9 miles. Then, at an agreed signal, the X-15 fell away from its mother aircraft, its engines lit, and it roared away and upwards. Joseph Walker, who piloted the X-15, intended to fly to a height of 315,000 feet, but owing to a tiny error he went far higher and, by accident, reached 350,000 feet, or approximately 67 miles above sea level. No aircraft had ever flown so high before.

The engine of the X-15 which carried Joseph Walker on his record flight was quite unlike those used to power conventional aircraft. It was a rocket motor in which the fuel burns, not in air as in an ordinary aero-engine, but in oxygen carried on board the aircraft and pumped into the engine with the fuel. As the rocket fuel burns in this oxygen a jet of intensely hot gas is formed to escape rearwards and drive the aircraft onwards and upwards. Rocket motors are expensive and difficult to operate, but there is a very good reason why this type of aero-engine was fitted to the X-15. . . .

For a moment let us imagine that the Earth, instead of being surrounded by an envelope of air, is wrapped in a great blanket of cotton-wool many miles deep. The outermost part of this 'wrapping', like ordinary cotton-wool, is very light and fluffy, but the layer immediately beneath has to support the weight of this outermost layer, and, in consequence, is just a little squashed. The next layer down supports both of the layers above and so is even more squashed. Thus it continues down to the surface of the Earth. The lower the layer the greater is the weight it has to support, and so, throughout the whole mass of cotton-wool, the pressure increases from above downwards. As a result of this increasing pressure, the *density* of the cotton-wool increases as we approach the surface of the Earth.

If you now imagine air in the place of the cotton-wool it is easy to understand that the same rules apply. Like the cotton-wool, the air in the outermost layers is uncompressed, but towards the Earth's surface the pressure gradually increases by reason of the air's own weight. In consequence the air becomes more and more dense. At sea level the pressure is about 14½ pounds per square inch, and the weight of a cubic yard of air is approximately two pounds.

As Walker flew higher the pressure and the density of the air through which he passed grew less and less. Within seconds of launching he reached levels where the pressure was so low and the air so rarefied that there was insufficient oxygen to sustain even a candle flame. Conventional aero-engines cannot possibly work under such conditions, for, without oxygen, their fuel will not burn. The only way to propel an aircraft at such a height is to use an engine which works independently of the air in which the plane flies. This is the reason why a rocket motor carrying its own supply of oxygen was chosen to power the X-15.

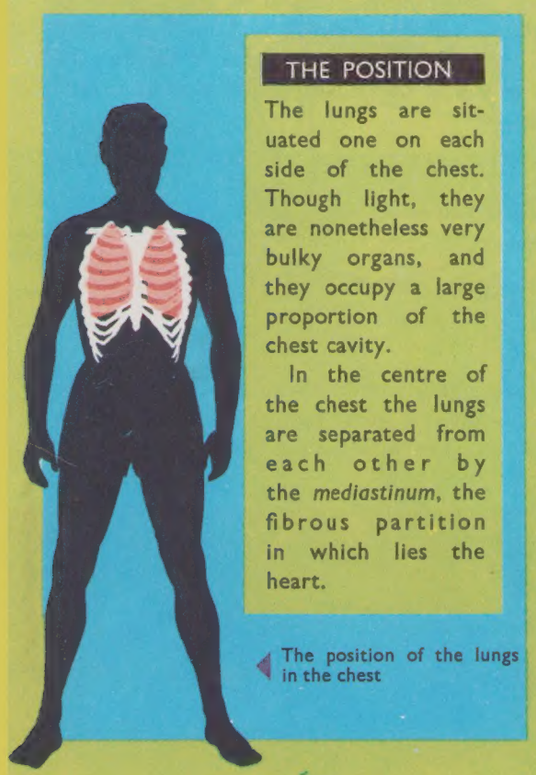
Although Walker reached the remarkable height of 67 miles, and although at that height the pressure of the air is only about one ten-millionth of the air pressure at sea level, he was nowhere near

THE ANATOMY OF THE LUNGS

EACH day an adult human breathes in and out approximately 25,000 times, and in so doing draws into the lungs about 600 cubic feet of air. From this great volume of air about 22 cubic feet of oxygen diffuse through the thin walls of the lungs' little air sacs and so reach the blood in the lung capillaries. Here this oxygen unites with the pigment, *haemoglobin*, in the red corpuscles to form the complex, *oxyhaemoglobin*. In this combined state it is carried to the tissues in all parts of the body.

When oxyhaemoglobin reaches the tissues the oxygen that it contains is released from the complex and diffuses immediately into the cells. Here it is used in the complicated oxidation reactions by which cells obtain energy from the nutritive substances provided by food. In these reactions carbon dioxide (CO_2) and water (H_2O) are formed. The carbon dioxide diffuses into the blood and is carried back to the lungs where it is lost in the air breathed out. The water is chiefly lost in the urine and the sweat.

The lungs thus perform two most important tasks. First they are the organs which extract vital oxygen from the air and transfer it to the blood. Secondly they allow unwanted and poisonous carbon dioxide in the blood to escape from the body in the expired air. As we study the anatomy of the lungs we shall see how well they are adapted for these tasks.



THE POSITION

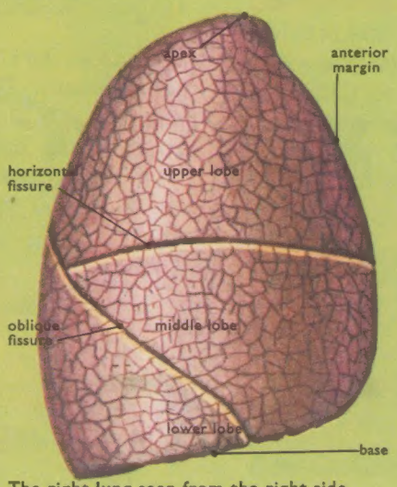
The lungs are situated one on each side of the chest. Though light, they are nonetheless very bulky organs, and they occupy a large proportion of the chest cavity.

In the centre of the chest the lungs are separated from each other by the *mediastinum*, the fibrous partition in which lies the heart.

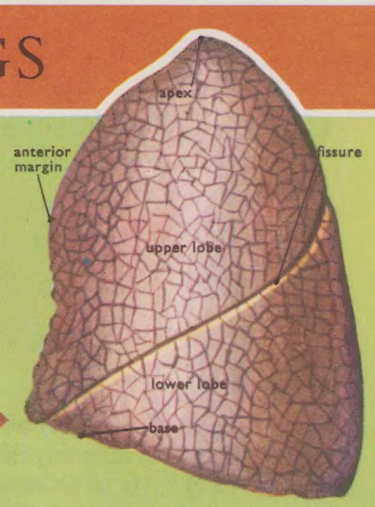
The position of the lungs in the chest

THE APPEARANCE OF THE LUNGS

The lungs are very much like sponge in texture. They are light and resilient, and when placed in water float readily. New-born babies have lungs which are a pleasant rosy-pink, but the lungs of adults are usually slatey-grey due to impregnation with particles of dirt and soot.



The right lung seen from the right side



The left lung seen from the left side

THE SHAPE

Each lung has a roughly conical shape. The apex of each cone is uppermost and lies just behind the collar-bone. The base is much wider and is formed by the part of the lung immediately above the diaphragm.

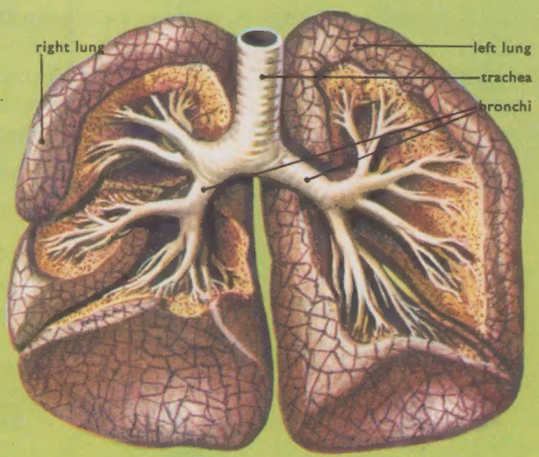
The right lung is a little larger than the left, and it is divided by two *fissures* into three quite distinct *lobes*. They are called the upper, the middle, and the lower lobes of the right lung.

The left lung has only two lobes, the upper and the lower. Its anterior margin is indented to accommodate the ventricles of the heart.

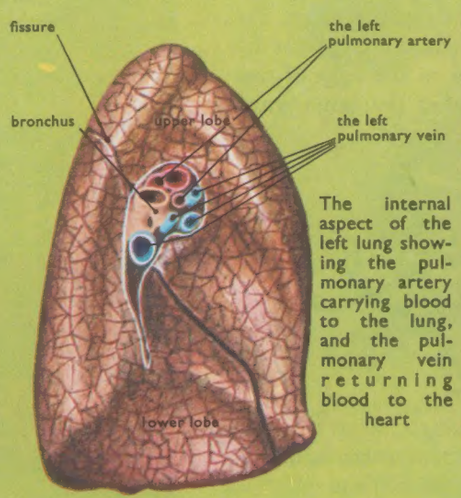
THE BRONCHI

At its lower end the windpipe, or trachea, divides into two branches, the right and the left *bronchi*. These air passages enter their respective lungs where they divide into ever smaller tubes which carry the breath to every part of the lung tissue.

The bronchi are held permanently open by a series of rings of cartilage in their walls so that the breath may always pass unobstructed along them. Similar, though smaller, pieces of cartilage are to be found in the walls of the smaller bronchi deep in the lung tissue.



The lungs seen from the front. Some of the lung tissue has been removed to show the branching of the bronchi



The internal aspect of the left lung showing the pulmonary artery carrying blood to the lung, and the pulmonary vein returning blood to the heart

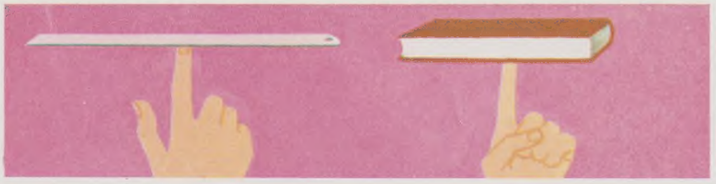
THE LOBULES AND ALVEOLI

Each of the tiniest bronchi, usually called a *bronchiole*, leads into a portion of lung tissue called a lung *lobule*. Each lobule consists of a series of minute little cavities surrounded by thin walls of lung tissue and each opening into the bronchiole. These cavities are the *alveoli* or air sacs.

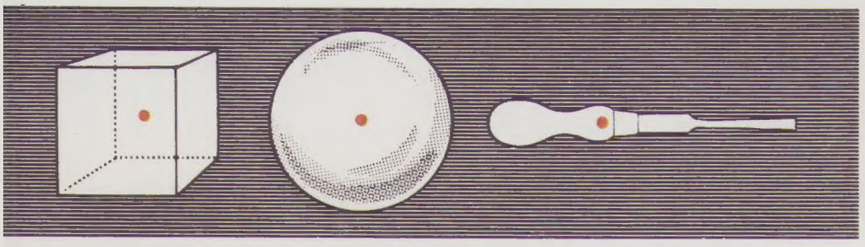
In the walls of the alveoli are tiny capillaries, and it is here that oxygen diffuses into the blood and carbon dioxide diffuses into the air.

CENTRES OF GRAVITY

YOU have probably all tried to balance a ruler or a book on a finger-tip.



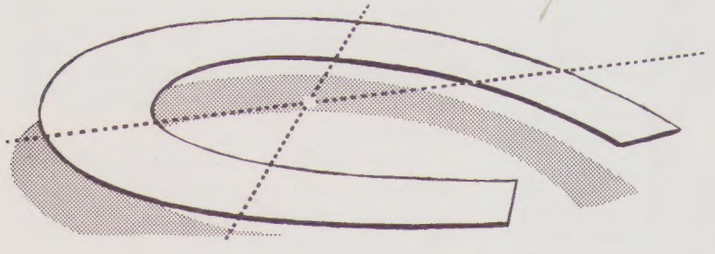
The point where an object may be supported without any tendency for it to move in any direction is known as its CENTRE OF GRAVITY (C of G for short). We can imagine this as a kind of average position of all the individual portions of the object; a point at which the whole weight may be assumed to act.



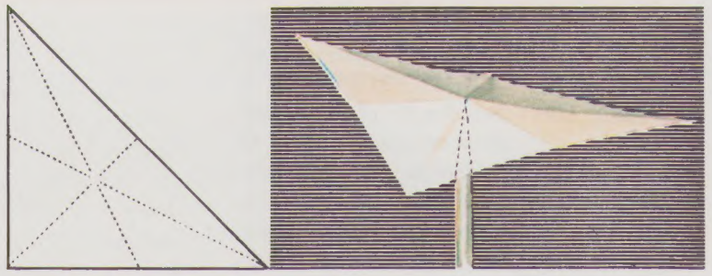
In regular-shaped objects, such as a uniform block or a sphere, the centre of gravity will be right in the middle. But in the case of an irregular-shaped object – for example, a solid metal screwdriver which has a thin, narrow piece at one end and a much broader, heavier handle at the other – the centre of gravity will be much nearer the heavier end.

Finding the position of the centre of gravity

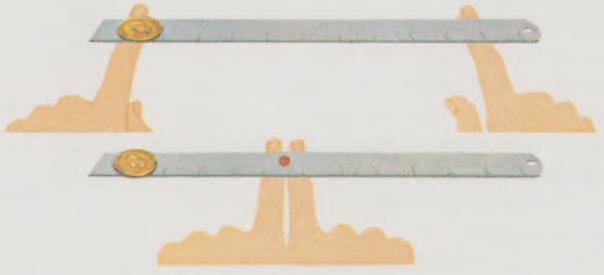
If you place an irregular-shaped piece of card on a table it will topple over when the C of G projects over the edge. To find its position we can place the card so that it is about to topple and mark a line on it corresponding to the edge of the table. Turn the card and mark another line in the same way. The intersection of these two lines shows the C of G.



If the C of G of a horseshoe-shaped piece of card is found by this method, it will be seen to be outside the object.



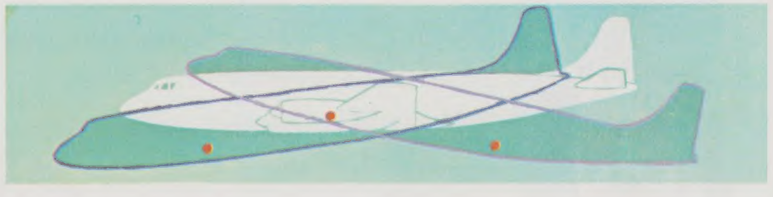
Sometimes the C of G may be determined by simple geometrical constructions. The C of G of a triangle is where the medians intersect. (A median is a line joining a corner to the mid-point of the opposite side.) You may test this for yourself by folding a triangular sheet of paper along the medians and checking that you can balance the triangle at this point of intersection.



Another way of finding the C of G without guesswork is as follows. Place a penny on the end of a ruler. Then, supporting the ruler with your fingers as shown, slowly move them together. The balance position you finally get corresponds to the C of G of the combined ruler and penny.

Stability

(a) In order to ensure stability the position of the C of G is important. For instance, if an aircraft is badly designed or if the weight of the cargo and passengers is incorrectly placed, the position of the C of G will result in a tendency to tilt.

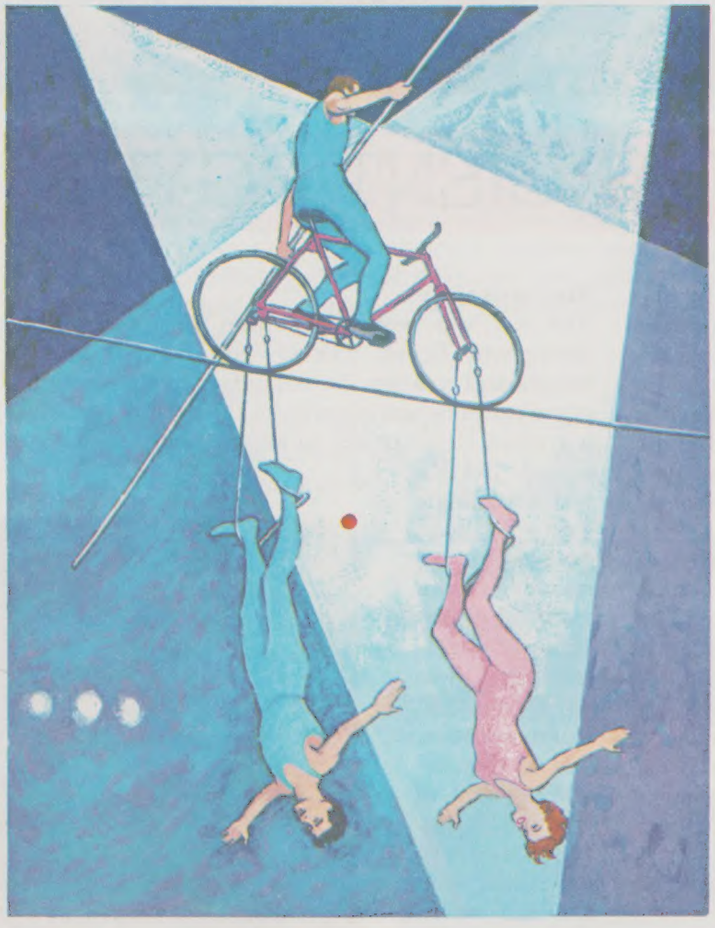


(b) Racing cars are designed so that the C of G is low and the wheel-base wide. Compared with a conventional car design, there is less tendency to overturn when cornering at high speed.

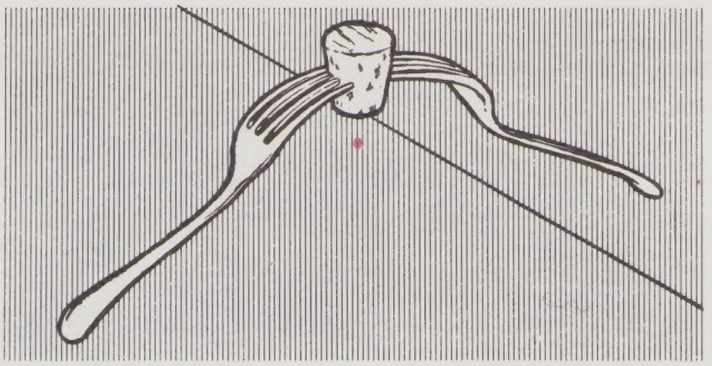
You can appreciate the reason for designing racing cars like this if you hold a large book on your outstretched hand and then turn around. When the book is flat you will be able to go much faster without it toppling than when it is upright.

When an object is supported from a point above the C of G there is stability, but if it is supported from below the C of G unstability results.

Some circus acts which look dangerous are, in fact, reasonably safe, depending as they do on this principle.

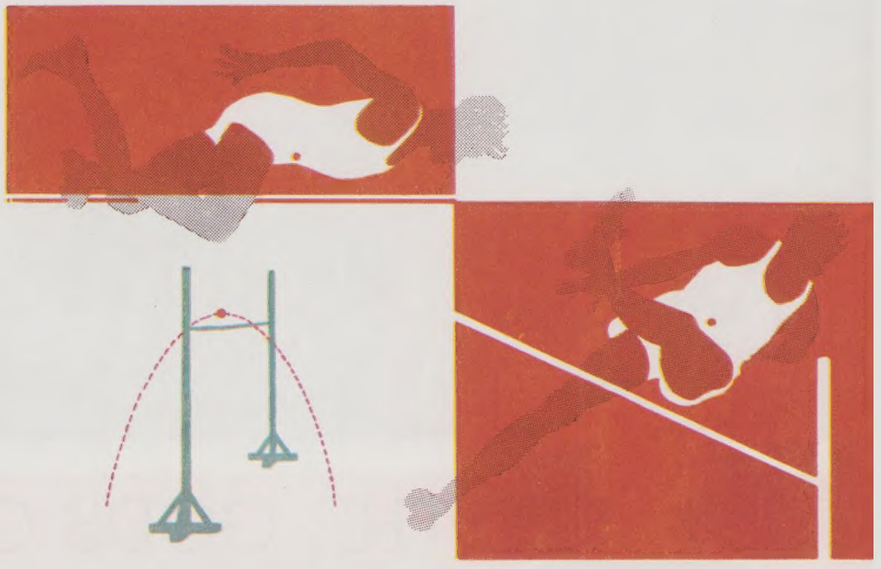


You can demonstrate this idea by pushing two forks into a cork as shown at the top of the next column. The combined body can then be balanced on a horizontal string.



Athletic movements

(a) An understanding of mechanical principles helps to explain why, for example, in the high-jump event the straddle style is more efficient than the scissors style.



Using the straddle technique, a jumper has to raise his C of G about 6 inches over the bar, whereas using a scissors technique, he may well have to raise it 18 inches over the bar, a far more difficult feat. In either case the path of the C of G is a parabola.

(b) In a rocket capsule moving freely in space, an astronaut who was not in contact with the sides would not be able to alter the position of his C of G whatever he did.

THE GODS OF ANCIENT EGYPT

THE Ancient Egyptians were described by the Greek writer Herodotus as 'the most religious of mankind'. They were *polytheistic* – that is, they worshipped many gods. These gods were believed to be the owners of the universe and the source of Egypt's prosperity. The people spent much time and effort building and rebuilding magnificent temples, performing religious ceremonies, and holding elaborate festivals, all in an attempt to please the gods.

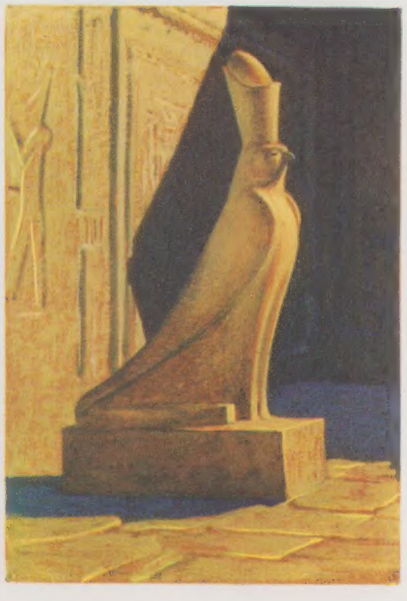
Altogether over 2,000 gods were worshipped at one time or another, including foreign gods which were freely imported, particularly from Syria. The gods appeared in paintings and sculptures, some with human and some with animal heads. But some of these gods were just different forms of other gods, for each district had its own variations, or local gods. As Egypt became unified (see pages 2120–2121) the many local deities were absorbed into a state religion with its centre at Heliopolis, city of the sun, where the sun-god was worshipped as supreme.

In the 15th century B C King Ikhnaton tried to introduce monotheism – belief in one god. This was strongly resisted by both priests and people until Ikhnaton's successor Tutankh-amen reinstated polytheism (see page 568).

Amon, worshipped for centuries as the supreme deity, carved in solid gold in the likeness of Thutmosis III (1500 B C)

Sun worship

The sun was worshipped from very early times throughout Egypt. The sun-god Ra was lord of heaven and creation (he had in fact created himself); in paintings he was often given the head of a hawk as a symbol of his power to move about the sky like a bird. But Ra was not a single god – he had many forms and names taken from different local gods. Horus (right) was one form; Itum, in human shape, was another, being the god of the setting sun. Ra, Ra-Atum or Amon was the sun at its highest point.



Horus, the falcon-headed god of the sky and rising sun

A scene from the Egypt of 1400 B C. *In a sacred barge statues of the sun-god Amon-Ra, his wife, and his son are carried with great reverence into the magnificent temple at Karnak near Thebes. The temple covered* 100 *acres and many of its* 70*-foot-high columns are still standing today*

Ra and his family formed a group of nine deities known as the Ennead, and they all kept their identities to the end of the Egyptian civilisation. The sun-god's children were Shu, god of the air; Tefnet, goddess of moisture; Geb, god of the earth; and Nut, goddess of night. Their children were Osiris, Seth, Isis, and Nephtys.

Cult of the god-king

The priests of the sun-god taught that Ra was the first king of Egypt, followed by the Ennead and then by Horus, from whom all other kings were descended. Egyptian kings were worshipped as reincarnations of the gods and were often shown in their likeness, particularly with the falcon's head of Horus. It was the king's duty to keep the temples in good repair as a sign of his respect for his divine ancestors.

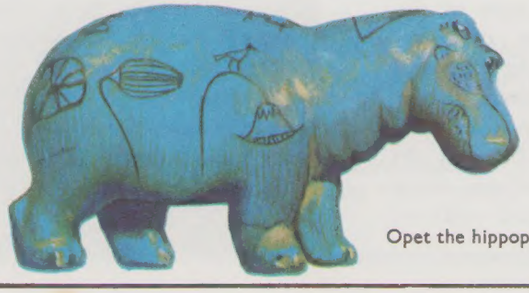
Importance of the river Nile

The Egyptians relied on the Nile for their food supply; its annual flooding brought down the fertile mud on which they grew their crops. Before and after the floods ceremonies were held to ask or thank the gods for their help, at which magic spells were used to increase the fertility of the soil.

ANIMALS SACRED IN ANCIENT EGYPT

Animals which gave their heads or complete forms to gods were considered sacred. The cat, at first companion to Bubastis, goddess of women, fashion, and love, eventually became identified with her. The hippopotamus goddess Opet, the great one, had a yearly festival at Thebes. Sebek was the dreaded crocodile god, and the cobra was revered as guardian of the tomb.

Sebek the crocodile



Opet the hippopotamus

cobra

cat – goddess of love

Life after death

The Egyptians were more preoccupied with death and the possibility of life after death than any other race that has ever lived. They were a cheerful, vital people who did not wish to admit that life could ever end. So they devoted an immense amount of thought and energy to preparing for a life beyond the grave.

At first they believed that the body of someone who had died came to life again at certain times; therefore the body had to be perfectly preserved (by mummification) and the tomb supplied with all the comforts and necessities of life. Later came the idea that it was the *ka* or spirit that came alive. Coupled with this was a belief in judgement after death – the most important contribution that the Ancient Egyptians made to religious thought.

The dead were judged by the rulers of the land of the dead: the 'Princes of the West', Osiris and the jackal-headed god Anubis. The jackal used to dig up graves in the desert, so the Egyptians made it a god in the hope that it would then cease these unpleasant activities. The dead man's heart was weighed in a balance against a feather (representing justice and truth). Those who failed the test were either devoured by monsters or sentenced to be reborn as a pig or other unclean animal; those who succeeded lived with the gods. The names of the dead were written on a scroll by Thoth, ruler of the moon, stars, and seasons, and god of wisdom, who had the head of an ibis (a sort of stork).

Anubis, god of embalming and the tomb

Elaborate preparations

This 'judgement scene' was often enacted during the funeral ceremony. A resounding 'Not Guilty' would be given in answer to all the questions put by the priest playing the part of Osiris; it was believed that punishment could be avoided simply by the denial of guilt and the use of certain magic charms.

At first only members of the royal family were thought to survive death, but gradually belief grew in an afterlife for all people. This meant that preparing tombs and performing funeral ceremonies became more and more important not just for the king but for everyone, to ensure a safe passage past the judges and into the next world.

Tombs were carefully prepared long before the future occupant was dead, and his family or friends were paid in advance for the funeral and subsequent care of the tomb. But these contracts were frequently broken and the tombs plundered of their riches; even the tombs of the pharaohs, thought to be gods themselves, were not respected and suffered the same fate.

The head of Osiris

ISIS AND OSIRIS

The story of Isis and Osiris, grandchildren of Ra, is almost as popular today as it was 3,000 years ago.

Osiris married his sister Isis (as was the custom in Ancient Egypt) and so aroused the jealousy of their brother Seth. Seth, a cross between a donkey and a pig, was the god of evil. Shortly after the wedding, Seth gave a feast at which he showed the guests a richly-ornamented coffin and promised to give it to whoever fitted into it exactly.

The coffin had been designed to fit only Osiris, and as soon as he lay in it Seth slammed the coffin shut and threw it into the Nile.

Isis spent many months trying to find her husband's body. When she finally succeeded, she used her magic power to restore Osiris to life.

Osiris found that he could no longer bear the light of the sun, so returned to the land of the dead and became its ruler. Isis joined him there and became goddess of the night sun – that is, the sun when it is below the horizon.

Seth's crime was not to go unpunished, however. Osiris' son Horus (or Harpocrates) fought Seth and killed him, thereby avenging his father's murder.

This story is remembered at harvest time whenever the corn is cut along the banks of the Nile; this stands for the killing of Osiris and the reappearance of the new crop as his restoration to life.

Seth, god of evil

THE MOST IMPORTANT BELIEF

The story of Isis and Osiris is the most outstanding expression of the Ancient Egyptians' belief in a life after death; just as Osiris could rise from the dead, so could they. A dead person was often said to be with Osiris or even to have become Osiris.

But Osiris represented more than life after death – he was also the judge of the dead. The Ancient Egyptians were the first to put forward a theory of punishment in the next world for deeds committed in this one. Punishment could be avoided, however, by the use of the right prayers or magic charms at the funeral ceremony; leading a blameless life to achieve the same end was apparently not considered.

THE NEW WORLD MONKEYS

WE dealt with the higher primates (apes and monkeys) of the Old World on page 2311. In the New World – that is, North and South America – there are no apes but a great variety of monkeys. The majority of them live in South America, but they are confined to the tropics, not being found below northern Argentina. In North America they inhabit only the southern, tropical parts of the continent.

The flat-nosed monkeys

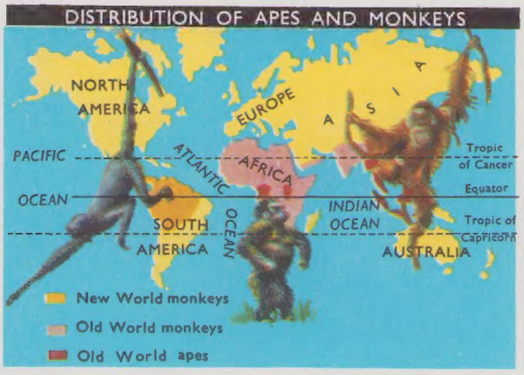
All these New World monkeys have widely separated nostrils and flattened noses, and most of them possess a total of 36 teeth in their jaws; they are sometimes classified as a single group, the *Platyrrhinae* or 'flat-nosed' monkeys. In distinction from them, all the higher primates of the Old World – monkeys, apes, and man – are classified as the *Catarrhinae* or 'downward-nosed' group, because their nostrils are close together and directed downwards. All the Catarrhinae have 32 teeth – that is, two fewer premolars in upper and lower jaws. This classification emphasises the rather surprising fact that the monkeys of the Old World are more closely related to man, from the evolutionary point of view, than they are to the New World monkeys.

They hang by their tails

Two other features are characteristic of New World monkeys. They do not generally have the thumb opposed to the other fingers, and many of them have a prehensile tail. *Prehensile* means 'holding on', and these monkeys are able to curl their tails round a branch, using them as a fifth limb in climbing. Some of them have an area of naked skin near the tips of their tails which is sensitive, serving as an organ of touch. This enables the monkey to select a good place to grip and makes its tail almost as useful as an extra hand. No Old World monkey has a prehensile tail. All the New World monkeys live among the trees, none of them being ground dwellers as, for instance, are the baboons of Africa.

The New World monkeys are divided into two families, the *Cebidae* and the *Callithricidae* or marmosets. The Cebidae are all obviously monkeys, but the marmosets are queer little squirrel-like creatures, often with brightly-coloured fur and long tufts of hair on their heads. Some of the Cebidae are fairly hardy in captivity, and the marmosets make very attractive pets, but they are delicate and seldom live long when kept in a temperate climate.

A black spider monkey swinging from a liana by its prehensile tail. The end of the tail is sensitive and can be used rather like a fifth hand



CLASSIFICATION OF THE HIGHER PRIMATES

	CATARRHINAE (Old World only)			PLATYRRHINAE (New World only)	
Families:	Cercopithecidae (Old World monkeys)	Pongidae (Apes)	Hominidae (Man)	Cebidae (New World monkeys)	Callithricidae (Marmosets)

CEBIDAE

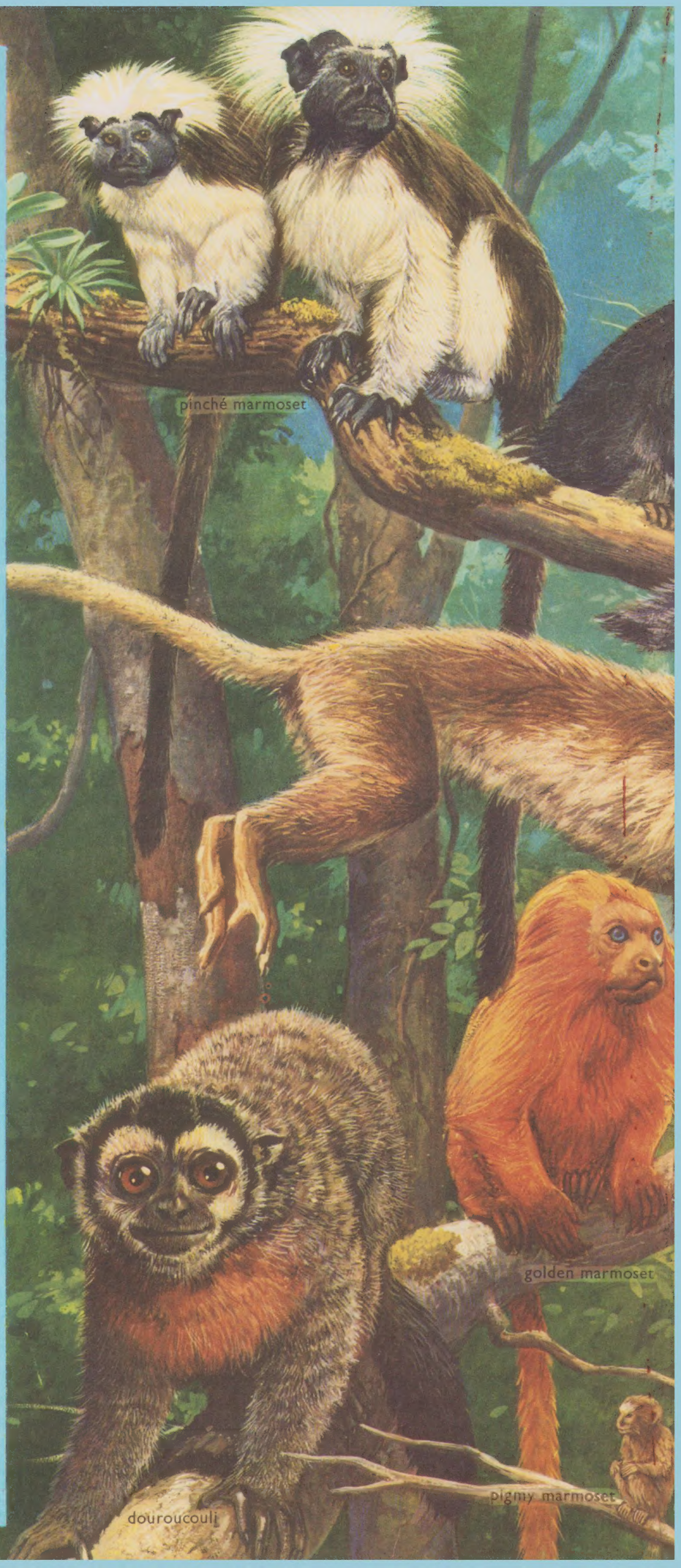
All the monkeys in this family have 36 teeth and many have prehensile tails.

WHITE-THROATED CAPUCHIN (*Cebus capucinus*); the capuchin monkeys are so called because the hair on their heads forms a kind of hood. This species lives in Central America and Colombia.
BROWN CAPUCHIN (*Cebus fatuellus*); the fur is brown, rather darker on the limbs, head, and tail. This monkey is found in Brazil and some of the neighbouring countries.
SQUIRREL MONKEY (*Saimiri sciurea*); squirrel monkeys are small and active, and their tails are not really prehensile. They live in large groups, sometimes over a hundred together, and are widely distributed in tropical South America.
DOUROUCOULI or NIGHT MONKEY (*Aotus trivirgatus*); this monkey has an owl-like face with very large eyes and is active only at night, sleeping by day in holes in trees. It is the only species of monkey that is nocturnal.
HAIRY SAKI (*Pithecia monachus*); the saki monkeys all have very long hair, especially on their heads, and bushy, non-prehensile tails. They live mainly in the Amazon and Orinoco valleys.
BEARDED SAKI (*Chiropotes satanas*); its appearance has led to this species being called *satanas* or 'devil-monkey', but it is really a timid and inoffensive creature.
BALD UAKARI (*Cacajao calvus*); this is an extraordinary-looking monkey with a bald head and face and stumpy tail.
BLACK HOWLING MONKEY (*Alouatta caraya*); this is the best-known member of the group called howling monkeys. They have large throat-sacs which amplify their voices so that they can be heard two or three miles away; they 'sing' most loudly at dawn and dusk. The tail is prehensile and naked near the tip, and they also have thumbs which are curved and opposed to the other digits – another adaptation for climbing. Howling monkeys are widely distributed from Mexico to northern Argentina.
BLACK SPIDER MONKEY (*Ateles paniscus*); the spider monkeys have very long, thin limbs and highly specialised prehensile tails with a naked sensitive part near the end. Their thumbs are entirely lacking, and their fingers are very long and form a kind of hook for holding on to branches. These monkeys are wholly specialised for climbing and hardly ever come down to the ground. Even when they want to drink they do so by reaching down from an overhanging branch and scooping up water with one hand. There is a picture of the black spider monkey on the previous page.

CALLITHRICIDAE

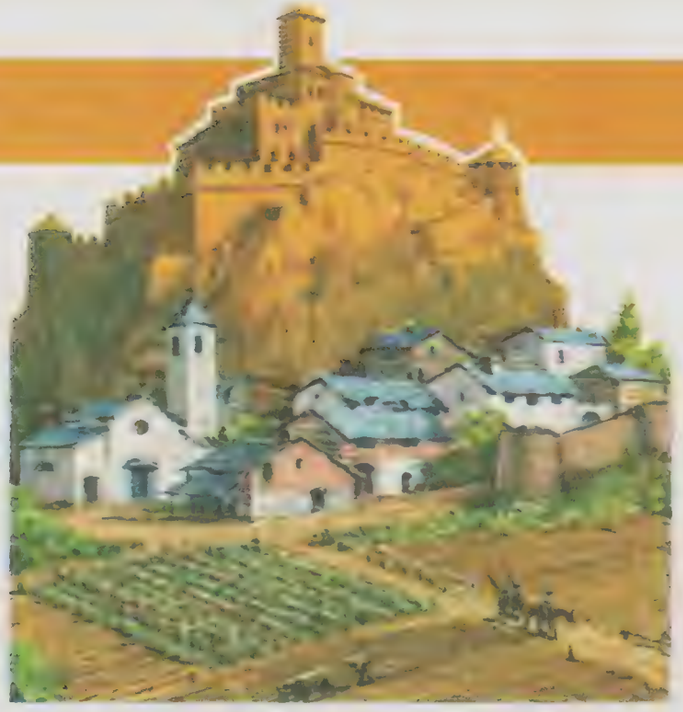
The marmosets are all small monkeys differing from the Cebidae in having only 32 teeth. The arrangement is not the same, however, as in the Old World monkeys, as marmosets have six premolars in each jaw (like the Cebidae) but only four molars.

GOLDEN or LION MARMOSET (*Leontocebus rosalia*); the beautiful, silky, golden hair of this marmoset is arranged like a mane on its head, and makes it look like a tiny lion.
PINCHÉ MARMOSET (*Oedipomidas oedipus*); this is a rare animal found only in eastern Colombia. Its voice is very remarkable, a pure piping and trilling, just like the song of a bird.
COMMON MARMOSET (*Callithrix jacchus*); this is the marmoset that is most often kept as a pet. It is a very pretty and charming little animal, with white ear-tufts, but it is difficult to keep in good health in a temperate climate; nevertheless common marmosets have been known to live as long as 16 years.
PIGMY MARMOSET (*Cebuella pygmaea*); this is the smallest of all the monkeys, with the head and body only 6 inches long.



Note: these monkeys are not all drawn to the same scale
common marmoset
hairy saki
bearded saki
white-throated capuchin
squirrel monkey
bald uakari
black howling monkey

FEUDALISM



ABOVE you can see men at work in their fields sometime during the Middle Ages; they are growing food for themselves and their families and for the priest who serves the village church; they are also growing food to feed the lord in the castle, his soldiers and servants. What happens if the lord of a neighbouring castle, or some raiders like Vikings, come with their soldiers to burn the crops of this village and steal the oxen? The village folk can take shelter behind the castle walls with their animals; and the lord of the castle can lead his men out to drive off the attackers. In peace, the peasants serve the lord, plough his fields, provide him with food, obey him. In return he protects them, and provides them with land from which they can make a living.

We examined the relationship of the mediaeval lord and peasant more closely in our article on the Lord and Manor (see page 1942). But what about the relationship between the lord and his superiors? Whom does he hold his land from, and what service must he do for it? He probably holds his land from a greater lord – for this he will have to do military service. The greater lord from whom he holds his land may be a tenant-in-chief or *baron* – that means he holds his land directly from the king. As he will hold a lot of land, he will have to provide the king with many knights. The arrangement for providing these knights he will have made by granting land to other lords who will themselves provide knights.

On the right you can see a tenant-in-chief about to do homage and swear fealty to the king. He kneels before him and then puts his hands between the king's; by this ceremony he becomes the king's 'man', his *homo* in Latin – hence 'homage'. Then he will rise to his feet and swear an oath that he will do faithful service to him – an oath of fealty or *fidelitas*, meaning faithfulness. The oath was a very solemn thing; by it, what was a *legal* obligation to do services in return for land was transformed into a *moral* one, to serve the king as a man. This, then, was the essence of feudalism: land given and received in return for certain services. The land granted was known in Latin as *feudum* or in English as a *fief*. This fief was the bond between lord and man which was the basis of mediaeval society from the 10th to the 13th centuries.

How feudalism began

In the early Middle Ages kings and nobles were also soldiers: they kept their power by war, and they enjoyed fighting. For many of those who did not enjoy fighting, or were not able to join in, life was hard; and even those who did enjoy warfare preferred it to take place on someone else's land. They wanted to have peace at home and war abroad. Everyone not strong enough to look after himself wanted a protector. It was in this troubled sort of society that feudalism began and flourished.

A vassal is about to do homage to his king by

But, as we have seen, protection was by no means all of the feudal contract. The most important part of it was land. In the early Middle Ages kings had paid their soldiers by winning booty and dividing it among their troops. As time passed, booty became more difficult to find, and so kings won support by giving their soldiers plots of land. But the kings found that if they went on giving land away to their soldiers they soon had no land left to give. So they made an arrangement that each estate they handed over would always be held by a warrior who would serve them. The land did not become the property of this warrior. He had the use of it so long as he fought for the king in his wars.

The Norman Conquest of England

There had been a partly feudal society in England before the Norman Conquest. After the battle of Hastings (see page 474) William the Conqueror handed out most of the land which had belonged to Saxon lords to his own followers. In the process England became more completely feudal. When William gave an estate to a Norman lord, he told him precisely how many knights he expected him to produce for the royal army. This sounds simple, but in fact the Norman Conquest was a fantastic muddle. First the lord had to find out where his lands lay. If he had been given the estate of a Saxon lord, there might be bits of it in many different counties. The new lords squabbled and even fought over their properties, but eventually all the disputes were settled. Then the lord could begin settling his own knights on the land, finding plots of a suitable size for them so that the knights in their turn could guarantee to produce soldiers for the lord when the king demanded them.

PAYMENTS

In certain circumstances the lord could extract payments from his vassals: *aids* when, for example, he had to be ransomed or his first-born son came of age; *incidents* when, say, his tenant died before his heir took over.

SOME FEUDAL TERMS

Knight service: military service in return for land; *villein service:* minor agricultural services in return for land; *tenure in sergeanty:* non-military services in return for land; *scutage:* money paid in lieu of knight service; *diffidatio:* the action which a vassal can take to repudiate his contract if he thinks the lord has broken his; *distraint:* seizure of land or goods by a lord if his vassal breaks his contract; *escheat:* the return of the land to the lord if the tenant dies heirless.

The feudal pyramid: a peasant holds of a knight, who holds of a lesser baron, who holds of a tenant-in-chief, who holds of a king

putting his hands between the king's in the presence of the whole court

The feudal system

And so the Normans settled their knights, built their castles, fought for the king, and, when he let them, fought among themselves. King William thought England could produce 6,000 knights. It is very unlikely that he ever got so many together at one time. But he got a great number, and had a powerful army. His successors got a lot of money from knights who did not come to the feudal host, but paid *scutage* or shield money, so that mercenary troops could be hired. But plots of land continued for many generations to produce knights; and the castle and the feudal oath and the fief were tremendously important institutions. Because the theory at the bottom of it – that every fief produced its soldiers – was so simple, we call it the feudal 'system'. But because in practice the organisation of fiefs and arrangements for recruiting knights and taking oaths and counter-oaths were complicated, it would be better to call it the feudal muddle.

Map of Belgium

Geographical position of Belgium

AS the inset map shows, Belgium occupies only a small portion of Europe; its area (11,779 square miles) is less than one-quarter of that of England. But in spite of its small size, it contains a variety of landscapes, ranging from the flat, treeless polders of Maritime Flanders to the bleak, forested mountains of the high Ardennes, and from the large open wheat fields of Brabant to the smoking factories of Liège. This diversity is partly due to the differing physical evolution of the major regions and partly due to man's varying impact upon them. Although there is much local individuality there are three main regions. The first is the plain of Flanders, which stretches from the coast towards the south-east and includes the Scheldt valley. Beyond this, the land gradually rises, forming the low, undulating plateaux of central Belgium, which constitute the second region. The third consists of the Ardennes, a block of old mountains, rising to 2,283 feet in the Botrange ridge, the highest point in the country. They are separated from central Belgium by the Sambre-Meuse depression, which divides the sparsely peopled south-east from the densely populated north-west.

The heavy, powerful draught-horses of the region of Brabant

The plain of Flanders

This region contains two parts – Maritime (West) Flanders and Interior (East) Flanders. The coast is fronted by a broad, sandy beach and backed by a long rampart of dunes, often over 100 feet high. Behind the dunes is a zone of polders, flat lands reclaimed from the sea and artificially drained. The soil is mainly a fertile marine clay, but depressions mark the positions of old peat cuttings, while small hillocks of sand frequently provide village sites. Over half of the polders are in permanent pasture for cattle.

Interior Flanders lies between the polderlands and the low plateaux of central Belgium. It is a gently undulating plain with mainly sandy soils. These were once of poor quality, but through the early introduction of heavy manuring they have become as productive as the naturally fertile marine clays. This region is now one of the most densely populated

BELGIUM – physical

areas in Europe. Most of the farms are very small, and the tiny fields, surrounded by trees, are often cultivated on a garden scale; the crops include chicory, potatoes, and wheat. Thus the landscape is very different from the treeless pastures of Maritime Flanders.

This region has been a leading producer of textiles since the Middle Ages, when the manufacture of linen was based on the flax grown in the Leie valley and Antwerp was an important trading centre. Today cotton goods are more important.

A landscape in the Ardennes, with extensive pastures and thick forests

The low plateaux of central Belgium

This is a region of low relief containing few areas over 500 feet high. Between Turnhout and Hasselt lies the Kempenland (or Campine), which has a distinctive character differentiating it from the rest of the region. Its surface is formed of sterile sands and gravels, which give poor soils. Large areas of heath and marsh still survive, though much has been reclaimed by the widespread planting of conifers. Since the First World War there has been rapid industrial expansion, especially in coal mining. Although the coal is found at great depth, making mining very expensive, one-third of Belgium's total output of 30 million tons is produced here. Unlike the Kempenland, the remaining low plateaux are very fertile. Extensive tracts are covered with *limon*, a soil of wind-blown origin, which gives heavy yields of wheat and sugar beet. In contrast to Interior Flanders, the fields here tend to be large and hedgeless.

The Ardennes

The Ardennes are formed of old resistant rocks that have been intensively folded and faulted. The soil is poor and acid, while the climate is damp and unpleasant, and the area is thinly populated. The undulating hills are covered with pine forests, moors, and pastures. Because of their hardness the rocks are widely quarried, especially for road materials. In the valleys of the north-west stretches of arable land appear among the forests.

THE SAMBRE-MEUSE DEPRESSION

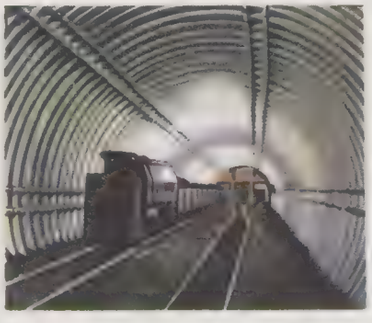
On the northern margin of the Ardennes is the Sambre-Meuse depression, which contains one-quarter of Belgium's population and most of its heavy industry. This great industrial complex is based on the coalfield located in this valley. Because of the exhaustion of the coal seams, high running costs, and the opening of the Kempenland field, the production of coal has declined since the last war. The district produces 90 per cent of Belgium's iron and steel and is also important for heavy engineering.

Two inhabitants of the Ardennes in traditional costumes

A land of waterways

Like its northern neighbour Holland, Belgium is a land of waterways, both natural and artificial. The two largest rivers, the Scheldt and the Meuse, are both navigable. The former, which rises in France, flows through Flanders to Antwerp, the great port situated on its estuary. The Meuse, which also rises in France, flows northwards, cutting a deep valley in the Ardennes. At Namur, where it is joined by the Sambre, it makes a sharp change in direction, flowing east towards Liège, before resuming its northerly course through Holland.

Because they serve major industrial areas, both rivers have been regulated and carry much freight traffic, especially coal, iron ore, and building stone. The rivers are supplemented by a dense network of artificial waterways, the most important being the Albert Canal, completed in 1940, linking the Meuse (below Liège) with the Scheldt. Altogether just under 1,000 miles of river and canal are navigable.



Monceau-sur-Sambre: the gallery of a coal mine

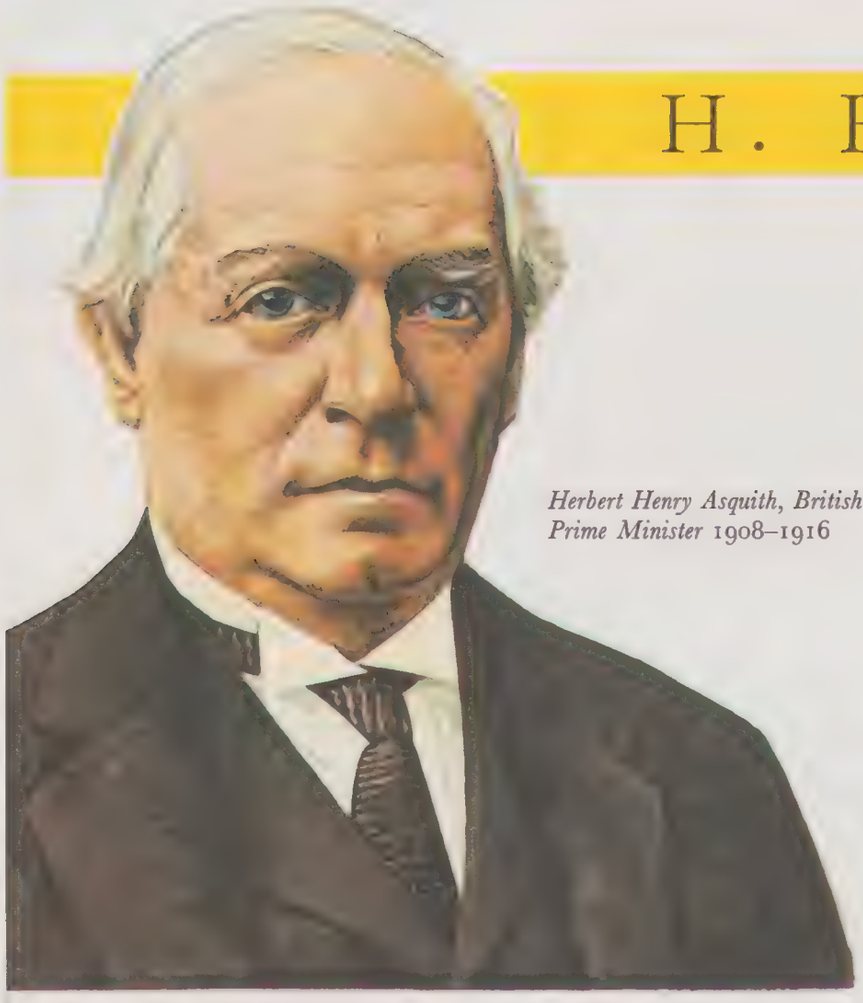
Climate

Belgium has a maritime climate much like that of south-east England. On the whole, winters are mild and summers warm, and the prevailing wind is from the south-west. Rain falls throughout the year, but is slightly heavier in summer; the annual average is 30 inches on the Flanders plain and 50 inches in the highest part of the Ardennes, which have a more extreme climate because of their altitude, and fog occurs there with unpleasant frequency.

Flanders: a section of the Maritime region with its sand dunes

A picturesque bend of the river Meuse in the hilly region of the Ardennes

H. H. ASQUITH



Herbert Henry Asquith, British Prime Minister 1908–1916

'MR ASQUITH was probably one of the greatest peace-time Prime Ministers we have ever had.' This was Winston Churchill's verdict of Asquith's administration, six years of which were spent at peace, the other two at war. These six peace-time years, from 1908 to the eve of the Great War, were among the most significant of this century: the parliamentary system was radically altered; the government embarked upon an enlightened programme of social welfare; the Liberal Party itself was, as we now know, threatened by the rise of the Labour Party; women clamoured for the vote; civil war was near over the Irish question; and meanwhile the clouds of war gathered over Europe. In fact, the comfortable world of the 19th century was giving way to the harsher one of the 20th century. And one of the central figures in this drama was Herbert Henry ('H. H.') Asquith.

He was born at Morley in Yorkshire on 12th September 1852. His father, a cloth manufacturer, died when he was a child; young Asquith went to London and he won a scholarship to Balliol College, Oxford, from the City of London School. There he had a brilliant career, gaining a double first in classics and a fellowship, and was President of the Union. His chosen profession was law, but this proved only a stepping-stone to politics. In 1886 he was returned to Parliament as Liberal member for East Fife, and in Gladstone's administration of 1892 he was made Home Secretary.

The Liberals were going through dark days. Split first on the Home Rule for Ireland question, ousted from office in 1895, they faced another crisis over 'imperialism'. Lord Rosebery (together with Asquith) supported a vigorous imperial policy while Campbell-Bannerman and his supporters (the 'pro-Boers') sympathised with the Boers in their struggles for independence. The breach was healed over another issue – free trade. Joseph Chamberlain advocated the overthrow of free trade in favour of 'imperial preference'. Asquith rejected Chamberlain's policy and followed him up and down the country, brilliantly answering his speeches point by point. He regained the support and confidence of the entire Liberal Party. After the Conservatives (under Arthur Balfour) fell in 1905 Campbell-Bannerman took office with Asquith as his Chancellor of the Exchequer.

Asquith made an excellent Chancellor. Each of his three budgets, in 1906, 1907, and 1908, showed a substantial surplus. The third was of the greatest importance, for it inaugurated Old Age Pensions of 5*s* a week payable, on a means test, to those over 70. The great Liberal programme of social welfare had begun.

Asquith introduced this third budget as Prime Minister, for on Campbell-Bannerman's resignation in 1908 he was the obvious successor. His cabinet was a strong one. David Lloyd George became Chancellor of the Exchequer and Winston Churchill was brought into the cabinet. It should not be forgotten that those great measures associated with the name of Lloyd George – the Housing and Town Planning Act (1909), the Trade Board Act (1909), Labour Exchanges (1910), the National Insurance Act (1911) – were the direct

King Edward VII, whose death on 6th May 1910 *came in the middle of a parliamentary crisis*

responsibility of Asquith as Prime Minister. But he was even more intimately concerned with the constitutional crisis which absorbed the nation between 1909 and 1911.

Showdown with the Lords

Lloyd George's budget of 1909 was known as the 'People's Budget'. In order to pay for the welfare schemes a land tax, together with many other legislative measures, was introduced into the budget. It passed the Commons and was rejected by the Lords. This, and the Lords' long record of obstructiveness, decided Asquith, and after twice holding an election he 'advised' the new king, George V, to create enough Liberal peers to get a Parliament Bill through which would abolish the House of Lords veto. But the Lords gave way, and on 18th August 1911 the Bill became law.

With the Bill through, Asquith faced other crises. He himself negotiated a settlement in the coal strike of 1912; he resolutely refused to panic before the militancy of Mrs Pankhurst and her suffragettes. But the Irish Home Rule question now dominated the scene. Asquith supported Home Rule, and according to the Parliament Act his Home Rule Bill, which passed the Commons, would automatically become law, despite rejection by the Lords, in two years. Yet between 1912 and 1914 one thing became clear: Ulster would fight to prevent incorporation into the proposed Irish state (see page 2240). There was also the question, would the army fight a rebellious Ulster? Asquith himself became Secretary for War in March 1914 in the face of this crisis; yet whether civil war would have come will never be known. For on 4th August 1914 Great Britain was at war with Germany.

War leader

Asquith as Prime Minister was mainly responsible for Britain's decision to fight in the First World War. He had been a party to all the promises and arrangements with France which gave Britain a moral obligation to help her against Germany. This does not mean he wanted war. The Haldane Mission (1912) and Churchill's proposals for a 'naval holiday' were earnest efforts to preserve peace. Nevertheless war came; the cabinet, which had been divided, united over the violation by Germany of Belgian neutrality (see page 1941).

Both the army and the navy were in superb condition, and in the war's opening months Asquith's speeches roused the nation as Chatham's had done before and Churchill's were to do later. But no Prime Minister could have foreseen the demands that this war would make on the country's resources, and criticisms of the Prime Minister grew. In 1915 he formed a Coalition with Bonar Law and other Conservative leaders and placed Lloyd George in charge of munitions. Ever since 1908 the mercurial and inspiring Welshman had tended to divert the public's attention away from his leader, and now he was to capture its support at Asquith's expense. What successes there were were credited to Lloyd George. The Prime Minister was accused, particularly by the popular press, of a negative policy. Lloyd George himself decided that Asquith was not the man to lead the nation in its crisis and resigned to force his hand. Asquith could not carry on without him, and Lloyd George became Prime Minister of the Coalition.

In opposition and retirement

The breach between the two men ruined the Liberal Party. Asquith was in opposition to Lloyd George and the Coalition, and after the war Lloyd George publicly supported those Conservatives who were candidates against the Asquith Liberals. Asquith lost his East Fife seat, but in 1920 he was returned for Paisley. In opposition he acted with dignity, and after his defeat in 1924 at Paisley by a Labour candidate he entered the Lords as Earl of Oxford and Asquith. Asquith retained the leadership of the Liberal Party, and in 1923 the Liberals were briefly reunited under him. But in 1926 a further difference with Lloyd George led to a final breach and Asquith retired from public affairs. In retirement he wrote *Fifty Years of Parliament* and in 1927 a volume of his speeches was published. His health broke down and he died on 15th February 1928.

Asquith married twice. His first wife, Helen, died in 1891. By her he had four sons and one daughter. By his second wife, 'Margot' Tennant, he had one son and one daughter. According to Churchill, Asquith's children 'are his best memorial', for several of them have led distinguished public lives. His brilliant eldest son, Raymond, was tragically killed in the Great War, but his daughter, Lady Violet Bonham Carter, was to display, according to Churchill, 'a force and talent equalled by no woman in British politics'.

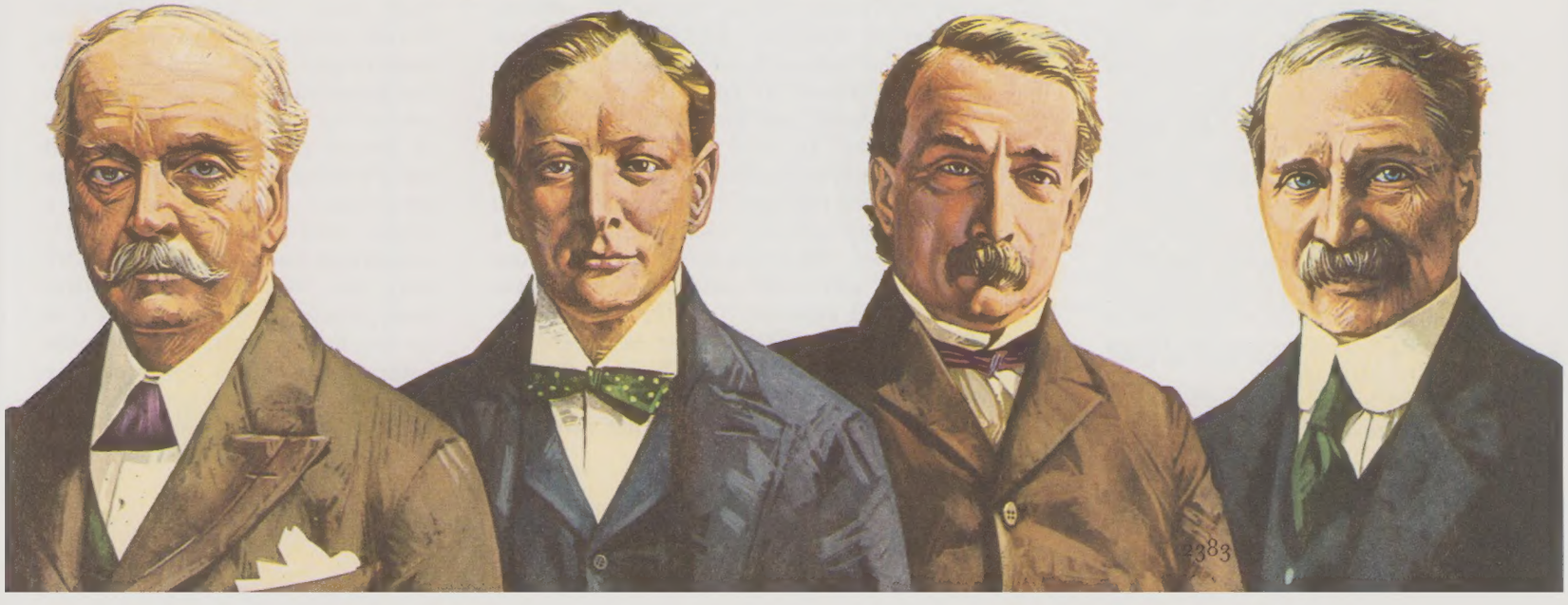
Asquith will be remembered as one of the greatest of parliamentarians – a man who came to quick decisions and stuck to them, cogent and clear in debate, who led his country ably in one of the most perilous times of her history.

Arthur Balfour – Conservative leader ousted in 1905

Winston Churchill – Asquith brought him into the cabinet

David Lloyd George – diverted attention from his leader

Andrew Bonar Law – Asquith brought him into the Coalition



CARDINAL RICHELIEU

THE 16th century was the century of Spain; the 17th that of France. That France came to dominate Europe was largely because Cardinal Armand Jean du Plessis Richelieu came to dominate France. Richelieu devoted his life to the greatness of his country. At his death he was able to say: 'I have no enemies but the enemies of France.'

France was weak and divided when Richelieu became First Minister in 1624. The horrors of the Wars of Religion (1562–1589) had not only plunged the nation into political and financial chaos but had also created a deep rift between Catholic and Protestant. Henry IV's Edict of Nantes (1598) had given the Huguenots (Protestants) a certain political and military independence. Indeed the Huguenots' stronghold of La Rochelle was a self-governing Protestant community. But Richelieu decided to end this situation – not for religious reasons, for his Catholicism was always subordinate to the national interests, but because he realised that uniformity was necessary if France was to be strong. So he invaded La Rochelle, which fell in 1628. The Huguenot power was broken – this was the first step in Richelieu's programme to make France the greatest nation in Europe.

Character

Richelieu was well equipped to carry out his ambitious programmes for France. He had an immense capacity for work, and his awe-inspiring personality, gaunt, grim features, and tall, emaciated figure hypnotised everyone with whom he came in contact. His rise was rapid. The son of a lesser nobleman, he was born in 1585 and consecrated a bishop in 1606. In 1614 he appeared as a spokesman for the clergy at the last States-General to be called before the Revolution. In this he impressed the Queen-mother, Marie de Medici, and in 1616 became Secretary of State. Suddenly his career was thrown into jeopardy. His patron, the King's First Minister, Concini, was assassinated in 1617. Richelieu followed Marie de Medici into exile while Louis XIII made Luynes, an enemy of both Richelieu and Marie, his First Minister. However, Luynes died in 1621, and Richelieu succeeded in reconciling the King and the Queen-mother. He was made a cardinal in 1622, and in 1624 himself became the King's First Minister.

Richelieu saw at once what France needed. The great nobles had grown enormously strong during the anarchy of the Wars of Religion. Richelieu determined to eliminate their independence in the same way as that of the Huguenots. He launched an attack on the nobles' privileges, and forbade their cherished custom of duelling. In 1626 he ordered the destruction of all castles not needed for France's defence. The nobles resented this high-handed treatment, but he dealt ruthlessly with all opposition. In 1627 a young nobleman, Montmorency-Bouteville, was caught duelling, and to the amazement of everyone Richelieu had him executed. In 1632 Gaston d'Orleans, the King's own brother and heir, rebelled; one of the greatest of all French noblemen, the Duc de Montmorency, Governor of Languedoc, joined him. The Duke's royal blood could not save him, and he was executed. Gaston was humiliated, and Richelieu was not to be troubled by revolts for a further 10 years. In 1642, the year of Richelieu's death, the King's favourite, Cinq-Mars, revolted. He too was executed.

Cardinal Richelieu (1585–1642), *father of 'absolute' government in France*

Richelieu had now virtually eliminated the nobility as dangerous political rivals. Between 1624 and 1642 he was the only really important man in France. His pride knew no bounds, and he claimed precedence at Court over even princes of the royal blood.

Foreign policy

Perhaps Richelieu's most important work was done not at home but abroad. The great conflict between France and the Austro-Spanish Empire of Charles V had been left unresolved by the Peace of Câteau-Cambrésis in 1559. But with the outbreak of the Thirty Years War in 1618 Richelieu decided that now was the time for the final showdown. His religion caused him no scruples about aiding Protestants against Catholics. He gave substantial aid to the anti-Austrian Christian IV of Denmark and particularly to Gustavus Adolphus of Sweden whom he brought into the field against Austria in 1630 at a cost of a million livres. In 1634 France entered the battle herself at a time when the Empire seemed on the verge of victory. Though the war began disastrously for France, when Richelieu died in 1642 success was in sight. French armies were in possession of Rousillon, Catalonia, and Turin, and the army had increased to over 150,000.

Richelieu and France

Richelieu made France strong abroad and the monarchy strong at home. Yet his own autocracy meant that where he was incompetent France suffered. Richelieu never came to grips with the chaotic financial situation; and because he suppressed the constitutional machinery of France (the States-General and the *Parlement*) it followed that the government would be weak if a future ruler was so. Louis XIV was strong, but Louis XV and XVI were not. Richelieu's administration played an important part in making France great; but among the causes of the French Revolution are those which can be traced to the administration of Cardinal Richelieu.

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the limit of the Earth's atmosphere. Indeed, it is difficult to fix an outside limit with certainty, for with an atmosphere which merely becomes thinner and thinner the farther away it is from the Earth, who can say where it ends and where space begins?

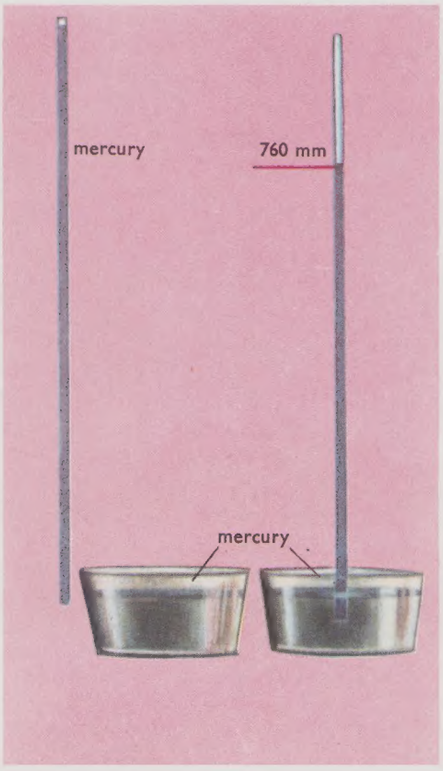
Air

'Air' is the word that we use to describe the gas which forms the atmosphere of our planet. Invisible, odourless, and tasteless, it is a complex mixture containing 20 or more quite different gaseous substances.

Two of the gases present in air are found in amounts far greater than all the others together. One is nitrogen which comprises about 78 per cent of the air, and the other is oxygen which comprises about 21 per cent. The remaining 1 per cent consists chiefly of argon (0·93 per cent), carbon dioxide (0·03 per cent), and helium, neon, krypton, hydrogen, xenon, nitrous oxide, methane, and water vapour.

Atmospheric pressure

When we think of the Earth wrapped in an imaginary layer of cotton-wool, we can quite easily understand that the cotton-wool would have weight, and that, in consequence, it would press down heavily on the Earth beneath. It is not quite so easy to be convinced that air, too, has weight, and that it also presses downwards very heavily.



The first satisfactory demonstration of the weight of the Earth's atmosphere was devised in 1643 by the Italian scientist Evangelista Torricelli. For his experiment Torricelli took a long thin glass tube and filled it completely with mercury. He then placed a finger tightly over the open end of the tube, turned the tube upside down, and immersed both his finger and the end of the tube in a mercury-filled vessel. Finally he removed his finger from the end of the tube and watched to see what happened to the mercury within.

In this experiment one might expect the mercury merely to run out of the tube and fill the vessel a little deeper, but, in fact, this does not happen. The mercury falls a little, it is true, but only until the top of its level in the tube is about 760 millimetres above the level of the mercury in the vessel. A mercury column 760 millimetres long is left standing in the tube, apparently against all the laws of gravity.

Strange though this result may seem, it can be explained quite easily. The empty space at the top of the tube is a *vacuum*. It contains nothing! There is therefore no pressure at all on the top of the mercury column. Within the column, however, the pressure increases from top to bottom by reason of the weight of the mercury, so that at the bottom the pressure is the same as the weight of the whole column. Now 760 millimetres of mercury presses downwards quite hard, and would certainly run out of the tube were there not something pressing back equally forcibly. There must be a force pressing on the surface of the mercury in the vessel and thus pressing the mercury *up* the tube. And indeed there is. It is the pressure of all the air which stretches upwards above the vessel. This column of air, 400 and more miles high, exerts the same downward pressure as the mercury in a column 760 millimetres high. The pressure of the air in the atmosphere exactly balances the pressure of the mercury in the tube.

Barometers

One of the interesting things about the Torricelli column is that it is not always exactly 760 millimetres high. The reason for the variations in its height is that the pressure of the air on the surface of the mercury in the vessel does not always remain the same. It may sometimes rise until it is sufficient to support a column of about 775 millimetres, and on other occasions fall until it will support only 730 millimetres.

These changes in the pressure of the atmosphere are due to the meteorological phenomena associated with our weather. Thus high pressure is caused by a mass of air moving downwards towards the Earth. In the northern hemisphere this air spirals in a clockwise direction and is called an *anticyclone*. It is almost always associated with good weather.

In exactly the opposite way a mass of air moving upwards will cause an area of low pressure. This air spirals in an anticlockwise direction and is called a *depression*. It is almost always associated with poor weather.

Now when the weather conditions change from those of an anticyclone to those of a depression, the amount of mercury that the atmosphere will support in the Torricelli column decreases, sometimes by as much as 40 millimetres. Anyone watching the column carefully during this time could predict a change for the worse in the weather. This is the principle on which the mercury barometer is based.

The regions of our atmosphere

Although the Earth's atmosphere is continuous in the sense that it extends un-

No. 149 Volume 13

Knowledge

Printed in Great Britain by Purnell & Sons Limited
Paulton, Nr. Bristol

Published by arrangement with
Fratelli Fabbri Editori
Milan

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interruptedly from the Earth's surface to its farthest limit in space, it is far from uniform. Five different 'layers' or regions are recognised, which are known as the *troposphere*, the *stratosphere*, the *mesosphere*, the *ionosphere*, and the *exosphere*.

THE EXOSPHERE is the outermost layer of the Earth's atmosphere. It begins about 400 miles above the Earth's surface. It is in this layer that some forms of Polar Lights occur. Since in this layer there is very little air to absorb the heat of the sun's rays, the temperature of anything on which they shine rises rapidly, probably to more than 2,500°C.

THE IONOSPHERE extends from about 50 miles to about 400 miles above the Earth. In this layer some of the gas atoms are *ionised*, or electrically charged. It is these charged particles which reflect radio waves from a transmitter to a distant point on the Earth's surface. Many of the phenomena known as Polar Lights occur in the ionosphere, and also, in this region, many small meteors burn out and appear as 'shooting stars'.

THE MESOSPHERE, or middle layer, lies above the stratosphere. It reaches from about 20 to about 50 miles up. In its lower levels it is rich in ozone (O_3). This gas is formed by the action of the sun's ultra-violet rays on the atmospheric oxygen. In the process the rays are absorbed and we on Earth are protected from their lethal effects.

THE STRATOSPHERE, 8 to 20 miles high, is the layer immediately above the troposphere. Here the air temperature is much lower than in the troposphere, being about —60°C. The atmospheric pressure is so low that a human's blood would boil.

THE TROPOSPHERE is the lowest layer of the atmosphere, and as such is the layer in which we all live and breathe. It extends from ground level to a height of about 8 miles, and is a little thicker at the equator than at the poles. In the troposphere occur almost all the meteorological phenomena that we speak of as 'weather'.